13. (Amended) A deposited-film formation method comprising the steps of:

providing a discharge electrode in a vacuum vessel equipped with exhaust means;

supplying a hydrogen gas and a raw material gas for forming a deposited film which contains at least an Si element;

generating plasma from the material gas by supplying high frequency electric power of 1 MHz to 200 MHz to the discharge electrode; and

forming a deposited film on a substrate in the vacuum vessel by plasma CVD,

wherein an auxiliary electrode is arranged in plasma in the vacuum vessel, a periodic electric field having a frequency of 100 kHz to 5 GHz is applied to the auxiliary electrode, and only electrons are energized without energizing ions to discompose a hydrogen gas and generate hydrogen radicals, thereby forming a deposited film and controlling the generation of the hydrogen radicals.

## REMARKS

The claims are claims 1-6 and 9-26, with claims 1, 11-14 and 24-26 being independent. Claims 14-26 have been withdrawn from consideration by the Examiner as directed to a non-elected invention. Claims 7 and 8 have been cancelled. Claims 1 and 11-13 have been amended to better define the present invention. Support for this amendment

may be found, inter alia, in the specification at page 13, line 21, through page 14, line 12, and page 15, line 2, through page 16, line 2. Claims 6 and 10 have been amended for clarification. No new matter has been added. Reconsideration of the claims is expressly requested.

Claim 10 is objected to by the Examiner. Applicants have amended this claim, changing "high melting point metal" to --high melting point metal--, as suggested by the Examiner. Accordingly, this objection should be withdrawn.

Claims 6 and 8 stand rejected under 35 U.S.C. § 112, second paragraph, as being allegedly indefinite. Applicants have amended claims 6 to clarify that a plurality of auxiliary electrodes is arranged at least in the flow path of plasma and cancelled claim 8. Withdrawal of this rejection is therefore respectfully requested.

Turning to the objections over the cited prior art, claims 1-7 and 9-11 stand rejected under 35 U.S.C. § 103(a) as being allegedly obvious from U.S. Patent No. 4,795,529 (Kawasaki). Claims 1-5, 7, 8 and 11-13 stand rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over U.S. Patent No. 5,980,999 (Goto) in view of U.S. Patent No. 5,662,819 (Kadomura). Claims 1-5, 8 and 11 stand rejected under 35 U.S.C. § 103(a) as being allegedly obvious from U.S. Patent No. 6,106,678 (Shufflebotham). Applicants respectfully traverse the grounds of rejection.

Prior to addressing the merits of rejection, Applicants would like to briefly discuss some of the key features and advantages of the presently claimed invention. The present invention is directed to a method for depositing a film in which high frequency electric power of 1 MHz to 200 MHz is applied to the discharge electrode and a

periodically changing voltage or a periodic electric field having a frequency from 100 kHz to 5 GHz is applied to the auxiliary electrode, which is located in the plasma stream. This change in voltage or application of the periodic electric field is such that it results in the efficient and controlled formation of hydrogen radicals from hydrogen gas and does not cause the auxiliary electrode to discharge.

Thus, by avoiding the discharge, the current running through the auxiliary electrode can be set at a low level and the electrode can undergo only minimal heating. As a result, it is possible to deposit a very uniform film on a substrate without leaving a trace of the auxiliary electrode even if this electrode is located relatively close to the substrate surface. Further, the claimed changed in auxiliary electrode voltage or an application of the periodic electric field imparts a specific energy to the electrons, which results in efficient and controlled formation of hydrogen radicals. (Specification, page 11, line 2 - page 13, line 20).

Kawasaki is directed to a method and an apparatus that is capable of carrying out both etching and deposition. However, Kawasaki is substantially different from the presently claimed invention. First, this reference is silent about periodically changing the voltage having a frequency as presently claimed so as to avoid a discharge. The Examiner has alleged that this disclosure is inherent in Kawasaki since "the auxiliary electrode is being used for the acceleration of plasma but not to ignite it." Applicants respectfully disagree with the Examiner's interpretation of the term "discharge" in the context of the present disclosure.

The instant specification, at page11, line 2, through page 13, line 2, defines and describes in detail what is meant by the term "discharge" and how an auxiliary electrode does not have to generate plasma to cause a discharge. The Examiner will note that as defined by the subject specification, a discharge occurs when the electrons accelerated by the auxiliary electrode are affected by a change in the auxiliary electrode voltage. For example, it is clearly stated in the specification that a discharge may occur if the maximum amplitude of the voltage exceeds 80V (page 11, lines 22-25).

Thus, Kawasaki fails to recognize that periodically changing the auxiliary electrode voltage may result in a discharge of electrons that are being accelerated. In fact, Kawasaki teaches alternating the voltage merely to control the change between etching and deposition. Therefore, this reference clearly cannot teach or suggest how to periodically change the voltage to avoid a discharge that can be caused by the auxiliary electrode.

Further, accelerating electrons by periodically changing the voltage or applying a periodic electric field as presently claimed results in an efficient generation of hydrogen radicals from hydrogen gas, which is another feature of the presently claimed invention that is missing in Kawasaki, as the Examiner recognized on page 3 of the Office Action. The Examiner, however, alleged that it would have been obvious to use hydrogen gas in the process taught by Kawasaki. Again, Applicants respectfully disagree.

Applicants have not found, and the Examiner has not pointed out, one iota of disclosure that would teach or suggest using hydrogen gas and controlling the generation of hydrogen radicals in an apparatus by periodically changing the auxiliary electrode voltage or applying a periodic electric field as presently claimed. In fact, one of the

references cited by the Examiner, Goto, teaches that when hydrogen gas is used, the voltage that is applied to the second electrode should not be changed. The Examiner will note that Goto was issued in November 1999, which is almost 11 years after the issue of Kawasaki and less than 5 months before the filing of the priority application in the present case. Thus, to a person skilled in the art at the time the present invention was made Goto would have suggested that to efficiently generate hydrogen free radicals, the auxiliary voltage should remain constant. This teaching is clearly contrary to the presently claimed invention.

In sum, Kawasaki does not disclose or suggest several key features of the present invention. In particular, it fails to teach using a periodically changing voltage or a periodic electric field having a frequency of 100 kHz to 5 MHz that is applied to the auxiliary electrode to control the formation of hydrogen radicals (all claims) without causing a discharge (claims 1-6, 9 and 10). Accordingly, Kawasaki cannot render the present invention unpatentable.

Goto is directed to a method for manufacturing a functional material thin film by introducing controlled radicals into plasma. However, this reference does not disclose or suggest an auxiliary electrode that is located in the plasma stream. The lower electrode 105 in Goto is located beneath the substrate and is not in the plasma stream. It is clear that the position of the auxiliary electrode greatly influences both the speed and the uniformity of deposition.

Further, this reference, like Kawasaki, fails to suggest using a periodically changing voltage or a periodic electric field having a frequency of 100 kHz to 5 MHz that

is applied to the auxiliary electrode to control the formation of hydrogen radicals without causing a discharge. Applicants have already explained in the above discussion of Kawasaki that when an auxiliary electrode is placed in the plasma stream, a change in the electrode voltage can result in a discharge that is deleterious to the formation of a uniformly deposited film. Therefore, clearly, as defined by the subject specification, the fact that an electrode does not generate plasma does not mean that a discharge does not occur.

With respect to the periodically changing voltage or applying a periodic electric field to control the formation of hydrogen radicals, the Examiner has readily recognized that Goto does not disclose this feature. However, the Examiner cited Kadomura to provide this missing teaching. Applicants disagree.

The Examiner will note that Kadomura does not disclose or suggest changing the voltage of or applying a periodic electric field to the auxiliary electrode to control the formation of hydrogen radicals from hydrogen gas. This reference is directed to forming poly-atomic radicals, such as $CF_2$*. Hydrogen radicals are discussed only in the background section of Kadomura as byproducts of the decomposition of $CH_2F_2$ or $CHF_3$ gases taught in the prior art, which was by this deemed by this reference to need improvement. Kadomura does not mention formation of hydrogen radicals from hydrogen gas or that periodically changing the voltage or applying a periodic electric field as presently claimed will result in a controlled formation of hydrogen radicals.

In sum, Goto, whether considered separately or together with Kadomura, fails to teach or suggest:

(a) an auxiliary electrode in the plasma stream;

(b) using a periodically changing voltage or a periodic electric field having a frequency of 100 kHz to 5 MHz that is applied to the auxiliary electrode to control the formation of hydrogen radicals; and

(c) periodically changing the voltage having a frequency of 100 kHz to 5 MHz that is applied to the auxiliary electrode without causing a discharge.

Clearly, the present invention is patentable over Goto and Kadomura.

Shufflebotham is directed to a method for high-density plasma deposition of silicon dioxide. This reference, however, suffers from the same deficiencies as Goto. Specifically, Shufflebotham fails to disclose or suggest:

(a) an auxiliary electrode in the plasma stream;

(b) using a periodically changing the voltage or a periodic electric field having a frequency of 100 kHz to 5 MHz that is applied to the auxiliary electrode to control the formation of hydrogen radicals; and

(c) periodically changing the voltage having a frequency of 100 kHz to 5 MHz that is applied to the auxiliary electrode without causing a discharge.

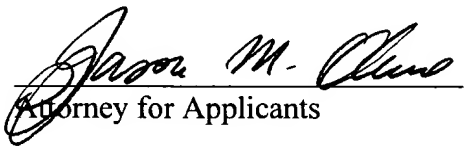
Further, as mentioned by the Examiner on page 6 of the Office Action, Shufflebotham does not disclose or suggest generating plasma via a discharge electrode. Therefore, this reference fails to disclose or suggest almost every claimed feature. Clearly, Shufflebotham cannot affect the patentability of the present invention.

In conclusion, the cited references, whether considered separately or in any combination, do not teach or suggest the combination of elements presently claimed.

Therefore, Applicants respectfully request that all objections and rejections be withdrawn an the present case be passed to issue.

Applicants' undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All correspondence should continue to be directed to our below listed address.

Respectfully submitted,



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VERSION WITH MARKINGS SHOWING THE CHANGES MADE

1. (Amended) A deposited-film formation method comprising the steps of:

providing a discharge electrode in a vacuum vessel equipped with exhaust means;

supplying a hydrogen gas and a raw material gas for forming a deposited film which contains at least an Si element;

generating plasma from the material gas by supplying high frequency electric power of 1 MHz to 200 MHz to the discharge electrode; and

forming a deposited film on a substrate in the vacuum vessel by plasma CVD,

wherein an auxiliary electrode is arranged in plasma in the vacuum vessel, and a periodically changing voltage having a frequency of 100 kHz to 5 GHz is applied to the auxiliary electrode without causing a discharge to form a deposited film while controlling generation of hydrogen radicals.

6. (Amended) The deposited-film formation method according to claim 1, wherein a plurality of [the plural] auxiliary electrodes is [are] arranged at least in a flow direction of the material gas.

7. Cancelled.

8. Cancelled.

10. (Amended) The deposited-film formation method according to claim 1, wherein the auxiliary electrode is formed from a round bar which has a small diameter and which is made of a high strength material of a high melting point metal.

11. (Amended) A deposited-film formation method comprising the steps of:

providing a discharge electrode in a vacuum vessel equipped with exhaust means;

supplying a hydrogen gas and a raw material gas for forming a deposited film which contains at least an Si element;

generating plasma from the material gas by supplying high frequency electric power of 1 MHz to 200 MHz to the discharge electrode; and

forming a deposited film on a substrate in the vacuum vessel by plasma CVD,

wherein an auxiliary electrode is arranged in plasma in the vacuum vessel, a periodically changing voltage having a frequency of 100 kHz to 5 GHz is applied to the

auxiliary electrode so that a voltage lower than the potential of plasma from the material gas is applied only in a certain period in at least one cycle of the periodically changing voltage, thereby forming a deposited film and controlling generation of hydrogen radicals [deposited-film].

12. (Amended) A deposited-film formation method comprising the steps of:

providing a discharge electrode in a vacuum vessel equipped with exhaust means;

supplying a hydrogen gas and a raw material gas for forming a deposited film which contains at least an Si element;

generating plasma from the material gas by supplying high frequency electric power to the discharge electrode; and

forming a deposited film on a substrate in the vacuum vessel by plasma CVD,

wherein an auxiliary electrode is arranged in plasma in the vacuum vessel, a high-frequency power of 1 MHz to 200 MHz [10 kHz to 500 MHz] is applied to the discharge electrode, and a high-frequency power of 100 kHz to 5 MHz [KHz or higher] to the auxiliary electrode, thereby forming a deposited film and controlling generation of hydrogen radicals [deposited-film].

13. (Amended) A deposited-film formation method comprising the steps of:

providing a discharge electrode in a vacuum vessel equipped with exhaust means;

supplying a hydrogen gas and a raw material gas for forming a deposited film which contains at least an Si element;

generating plasma from the material gas by supplying high frequency electric power of 1 MHz to 200 MHz to the discharge electrode; and

forming a deposited film on a substrate in the vacuum vessel by plasma CVD,

wherein an auxiliary electrode is arranged in plasma in the vacuum vessel, a periodic electric field having a frequency of 100 kHz to 5 GHz is applied to the auxiliary electrode, and only electrons are energized without energizing ions to discompose a hydrogen gas and generate hydrogen radicals, thereby forming a deposited film and controlling the generation of the hydrogen radicals.